8-1991

The Effect of the Elementary Science Methods Classes and Field Work on Student Attitudes toward Science and Science Teaching

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THE EFFECT OF THE ELEMENTARY SCIENCE METHODS CLASSES AND FIELD WORK ON STUDENT ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

THESIS

Submitted to the Graduate Committee of the
Department of Education and Human Development
State University of New York
College at Brockport
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Education

by
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August, 1991

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ACKNOWLEDGMENTS

The author wishes to extend thanks to Dr. Betsy Balzano for her inspiration and guidance and to Dr. Robert Ribble, who has successfully demonstrated the mastery approach to teaching.

Abstract

The attitudes of sixty-nine elementary education students toward science and science teaching were measured at three different times as they progressed through the Elementary Science Methods course at the State University of New York College at Brockport during the spring of 1991. The course was divided into two parts. During the first half of the semester, the students attended methods classes at the college. At approximately midterm, the students entered elementary schools to do field work. The instrument of measure employed was the Science Teaching Attitude Scales. The three scores for each subject were compared to determine if there was any growth of positive attitudes toward science and science teaching, thereby demonstrating the effectiveness of the Elementary Science Methods course. The results from this study demonstrate that the Elementary Science Methods classes are effective in producing positive changes in the subjects' attitudes toward science and science teaching. The subsequent field work is determined to not be effective in further improving students' attitudes.

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Introduction

Statement of the Problem

Students' attitudes toward and achievement in science are affected to a large degree by teachers' attitudes toward science and science teaching and their understanding of science processes. In general, elementary teachers possess less than positive attitudes toward science and science teaching, as demonstrated by the quality and quantity of the science experiences they offer their students.

Need for the Study

Teachers are being asked to produce scientifically literate citizens by offering their students the opportunity to develop observational, classification, and deductive reasoning skills as well as the ability to think for themselves. This requires the teacher to become a facilitator, rather than the director. The classroom atmosphere will, as a result, appear less structured as students become directly involved in science by observing, manipulating variables, and discovering things for themselves. Most elementary teachers have not been adequately trained in these teaching techniques. They rely on their own science experiences, from when they were in elementary school, which focused on the product, the "right" answer, versus the processes of science. Those teachers feeling insecure concerning their ability to teach science will be additionally threatened by the less structured atmosphere that goes along with discovery learning.

The fact is most elementary teachers are reluctant to teach science. By not addressing science or presenting it in an uninspiring manner, teachers are making an unspoken statement which their students are picking up all too clearly: "Science is not important, dull, and irrelevant to our lives." The lack of interest in science and insecurity in the ability to teach science are two of the most detrimental factors to effective elementary science teaching today.

Logically, science should be taught at the elementary level by teachers who possess positive attutides toward science and science teaching. But how are these positive attitudes cultivated? Who is primarily responsible for this? Educational programs preparing elementary teachers will obviously be held most responsible for the development of these positive attitudes. More specifically, the science methods course is a logical place to focus attention. Numerous studies have focused on preservice elementary teachers' attitudes toward science and science teaching, as well as how these attitudes can be made more positive. These studies rely on the belief that attitudes are learned, therefore positive attitudes can be taught (Moore, 1975; Shrigley, 1974a; Lucas and Dooley, 1982; Spooner, Szabo, and Simpson, 1982; Lawrenz and Cohen, 1985; and Stepans and McCormack, 1985).

Purpose

The question explored in this study is: What, if any effect do the Elementary Science Methods classes at the State University of New York College at Brockport and subsequent field work have on student attitudes toward science and science teaching. The Elementary Science Methods Course at this college is divided into two parts. During the first half of the semester, the students attend methods classes at the college. At approximately midterm, the students enter elementary schools for their field work.

Each student's attitudes toward science and science teaching will be measured at three different times as they progress through the Elementary Science Methods classes and field work. The first set of measurements will be obtained on the first day of the Elementary Science Methods class, before any instruction begins. The second set of measurements will be obtained on the last day that the Elementary Science Methods class meets, before the students enter the elementary schools to complete their field work. The final set of measurements will be obtained at the end of the semester, after the students have completed their field work. The three separate scores for each student will be compared to determine if there is any growth of positive attitudes, therefore demonstrating the effectiveness of the Elementary Science Methods course.

Definitions.

The students referred to are those elementary education students enrolled in the spring 1991 Elementary Science Methods course at the State University of New York College at Brockport.

The Elementary Science Methods course at the State University of New York College at Brockport is divided into two parts. During the first half of the semester, students attend methods classes at the college. During the second half of the semester, the students do field work.

The Elementary Science Methods classes are designed to address specific methods and basic principles of teaching science. They also emphasize the inquiry approach to teaching and the use of the processes of science.

The field work refers to the second half of the semester, when the students enter the elementary schools to observe practicing teachers. At this time, each student prepares and teaches at least one science lesson.

Attitude toward science refers to the positive or negative feelings, beliefs, or opinions one has toward science; what science is, how important one believes science to be, and what role science plays in today's society.

Attitude toward science teaching refers to how prepared the students feel in terms of science instruction, which takes into account their fears and concerns. It also refers to how important they believe science teaching is and how they will teach science in their classroom.

The pretest scores are obtained from the first set of measurements on the first day of the Elementary Science Methods class.

The midtern scores are obtained from the measurements taken on the last day of the Elementary Science Methods classes, before the students begin their field work. Since this occurs at approximately the middle of the semester, these scores are termed midterm scores.

The posttest scores are obtained from the measurements taken at the end of the semester, upon completion of the students' field work.

Rationale.

The dependent t-test will be employed to determine if there is any significant change in the student attitudes by testing the following three null hypotheses at the 95 % confidence level:

$H_{\emptyset_1}$: There will be no statistically significant difference between the pretest mean and the midterm mean when tested at the 95% confidence level.

$H_{\emptyset_2}$: There will be no statistically significant difference between the pretest mean and the posttest mean when tested at the 95% confidence level.

$H_{\emptyset_3}$: There will be no statistically significant difference between the midterm mean and the posttest mean when tested at the 95% confidence level.

Testing the first null hypothesis will determine the effectiveness of the methods classes that the students attend during the first half of the semester in developing the positive attitudes desired. The testing of the second null hypothesis will determine the effect of the combined experience of the methods classes and the field experience on the student attitudes. The results of testing the third null hypothesis will determine the effectiveness of the field work on the students' attitudes toward science and science teaching. In addition, Cohen's formula is employed to set the criterion of importance. By obtaining measurements at three separate times throughout the semester, it is hoped that strengths or weaknesses of the two separate parts of the Elementary Science Methods course can be identified.

It is predicted that the Elementary Science Methods classes should produce the growth of positive attitudes toward science and science teaching in the subjects. It is also hoped that the field experience will nurture further growth of positive attitudes in these students.

Limitations

Since the population for this study is limited to the elementary education students at the State University of New York College at Brockport, the conclusions drawn from the data obtained will not be generalized beyond the State University of New York College at Brockport.

Summary

It is hoped that the results obtained from this study will add to the growing body of knowledge of how elementary education students' attitudes toward science and science teaching change as they proceed through the Elementary Science Methods course.

Review of the Literature

Historically, at the elementary school level, especially kindergarten through grade 3, the importance of developing skills in reading, writing, and arithmetic has overshadowed the subject of science. The teaching of science at the elementary school level is, in many cases, nonexistent (Schoeneberger and Thomas, 1983). Many elementary teachers are reluctant to teach science because they feel inadequately prepared. They are asked to allow their students to become directly involved with the processes of science, but they do not know how to go about offering such experiences. After all, the experiences that many of these teachers had in their own elementary science lessons focused on facts and principles that were to be memorized. How can we expect these teachers to have a clear understanding of science processes, let alone positive attitudes toward science and science teaching? The fact is, negative attitudes toward science on the part of primary school teachers is reported throughout the world (Lucas and Dooley, 1982; Shrigley, 1974a). Even worse, attitudes are contagious. If teachers spend little or no time on science or present it in a dull manner, their students sense their negative attitudes and pick them up.

According to Lucas and Dooley (1982), these negative attitudes toward science may be traced to the elementary teachers' own experiences in school. They develop negative attitudes as a result of their inadequate science experiences at the elementary school level. As a result, these teachers, in turn, devote little or no time to science instruction or present it in such a way that their students find it unappealing and boring.

Vannan (1973) also found that elementary science experiences, or the lack of experiences, leave lasting impressions on prospective elementary teachers. His limited study focused on elementary education students' perceptions of their elementary science activities. Thirty-four percent of his subjects reported having no science instruction. Forced memorization of facts, scientists and their contributions, lack of field trips, and boring experiences without student involvement were just a few of the activities that the subjects reported recalling unfavorably.

Shrigley (1974a) recognized the dangerous potential of elementary teachers possessing negative attitudes toward science either avoiding the teaching of science in their classrooms or transmitting their negative attitudes to their students. His first study (1974a) focused on the science attitudes of preservice elementary teachers. One important finding that emerged from this study was that those preservice elementary teachers who experienced an organized science program at the elementary level reported significantly more positive attitudes toward science.

Duschl (1983) believes that preservice elementary teachers faced with two very different approaches to science teaching may be confused and insecure and therefore avoid science. His study was designed to determine what aspects of elementary education students' science training might lead to their apprehension toward science and science teaching. He found that preservice teachers were torn between the content-oriented objectives of the introductory level science courses they were enrolled in and the process-oriented objectives of their science methods classes.

"School children have a tendency to imitate attitudes of 'significant adults' when expressing their own attitudes" (Lawrenz and Cohen, 1985, p. 105).

It is imperative that we recognize how teachers' negative attitudes can impact on students' attitudes and achievement in science. However, recognizing the fact that these negative attitudes toward science and science teaching exist and can impact on students is not enough. The next logical step is to determine if these attitudes can be changed and how.

Moore (1975) conducted a study which focused on a project involving a four-week workshop and subsequent support meetings designed to prepare elementary teachers to teach the "new" elementary school science curricula. The results demonstrated that the workshop was successful in producing a significantly positive change in the participants' attitudes toward science and science teaching. The positive changes relating to attitudes toward science teaching were determined to be of a long-term quality; still significantly higher two years later. The positive effects on the partitipants' attitudes toward science did not demonstrate the same long-term quality.

Spooner, Szabo, and Simpson (1982) also provided support for the belief that negative attitudes toward science and science teaching can be made more positive.

Their study was designed to measure the effects of a five-day workshop, which used the Science Curriculum Improvement Study materials, on the attitudes of elementary teachers toward science and science teaching. The workshop was demonstrated to be successful in producing positive attitudinal changes.

Since it appears that positive attitudes toward science and science teaching can be learned, it is reasonable to direct attention to the educational programs preparing teachers to assure that they offer the opportunity to develop these desired attitudes. Shrigley (1974b) intended to determine the correlation between science knowledge and science attitude of preservice elementary teachers. The results demonstrated a low positive correlation between the two variables. Therefore, it cannot be assumed that cognitive level affects attitude toward science to any great extent. Shrigley concluded that enrolling prospective elementary teachers in more college science courses will not positively impact on their attitudes toward science.

The study performed by Stepan and McCormack (1985) yields similar information. The purpose of their study was to determine what affect the number and type of science courses completed had on preservice elementary teachers' attitudes toward science and science teaching, as well as their confidence in their ability to teach. It was found that merely increasing the number of traditional college science courses does not improve prospective elementary teachers' understanding of science concepts, attitudes toward science, or confidence in teaching science.

Shrigley (1974b) made an interesting recommendation. He suggested that there is a need to redesign the science learning experiences for preservice elementary teachers. He makes the observation that children are motivated to enjoy science through direct involvement in such processes as observation, inference, and manipulating variables. He suggests that prospective teachers might also benefit from similar hands-on experiences in their college science courses.

Since the traditional college science courses are not successful in producing positive attitudinal changes, the next logical consideration is the science methods course. In fact, research shows that science methods courses are successful in producing these positive changes (Morrisey, 1981; Lawrenz and Cohen, 1985).

This is not such a surprising finding since science methods courses focus on hands-on experiences, the processes of science, and the inquiry approach to teaching science.

Lawrenz and Cohen (1985) conducted a study to examine the attitudes toward science and understanding of science processes of elementary and secondary education students prior to taking the science methods course, immediately after completion of the methods course, and upon completion of their practice teaching experience to determine what, if any, changes occurred. Two significant findings emerged from this study. First, it was determined that science methods courses positively affected students' attitude toward science. Second, although there was no statistically significant change in attitude toward science during the practice teaching experience, a positive relationship was demonstrated between attitude toward science and time spent on science instruction. In other words, those subjects demonstrating more positive attitudes toward science were observed to spend more time on science in the classroom.

The study conducted by Lucas and Dooley (1982) examined how successful preservice science courses at Kelvin Grove College of Advanced Education were at fostering positive attitudes toward science and science teaching in primary school teachers. This study focused on two units for preservice teachers. One was a content-based unit which emphasized physical science and earth science. The second unit was based on principles of science curriculum. It was found that the content-based unit produced no significant change in students' attitudes toward science or science teaching. Although the science curriculum unit produced no significant change in students' attitude toward science, it did yield a significant improvement in students' attitude toward the teaching of science.

Morrisey (1981) summarized the findings of many studies on changing the attitude of elementary student teachers toward science and science teaching. This analysis of studies focused on specific variables that had been examined to determine if they might produce the desired attitudinal changes. Three of the variables investigated that might be easily incorporated into science methods courses were the inquiry approach, the process approach, and micro-teaching, i.e., small scale teaching situations. An interesting point that was made in Morrisey's article was that it might be a good idea to require that students in elementary science methods courses demonstrate positive attitudes toward science and science teaching to successfully complete the course. We emphasize such requirements for the cognitive domain. Why not extend such requirements to the affective domain?

Summary

Numerous studies have pointed to the ability of inservices, workshops, and college methods courses to provide for the development of positive attitudes toward science and science teaching. The basic premise is that if elementary teachers possess positive attitudes toward science and science teaching they will devote more time to science in their classrooms. They will also offer their students appropriate science activities which focus on the processes of science; allowing them to observe, manipulate variables, make inferences, draw conclusions, and think for themselves versus regurgitating memorized facts that will be forgotten in time. The end result is a more scientifically literate group of citizens.

The powerful implications of teacher attitudes toward science and science teaching appear clear enough to warrant further investigation of how elementary education students' attitudes change as they progress through science methods courses.

Design

Purpose

This study will examine the effectiveness of the Elementary Science Methods course at the State University of New York College at Brockport in developing positive attitudes toward science and science teaching in prospective elementary teachers. Specifically, the question to be explored is: What, if any, effect do the Elementary Science Methods classes at the State University of New York College at Brockport and subsequent field work have on students' attitudes toward science and science teaching?

Methodology

Subjects.

The population for this study is 69 elementary education students enrolled in the spring 1991 Elementary Science Methods course at the State University of New York College at Brockport. There were initially 71 students enrolled in this course, but two were lost through attrition.

Apparatus.

The instrument of measure to be used is the Science Teaching Attitude Scales (Moore, 1973). Moore noted that, although there were instruments developed to measure teachers' attitudes toward science, no instruments existed that assessed teachers' attitudes toward the teaching of science. He therefore developed scales to assess teachers' attitudes toward the teaching of elementary science. He then incorporated these scales with selected scales from the Science Attitude Inventory (Moore and Sutman, 1970) which assesses attitudes toward science. The resulting device measures intellectual and emotional attitudes toward science and science teaching. (See Appendix B for instructions to the subjects and the Science Teaching Attitude Scales.)

This instrument of measure consists of 70 items which test 14 attitudes. It therefore consists of 14 scales; 7 positive scales, each of which is paired to one of the 7 negative scales. Each scale is made up of a position statement of the attitude that is to be measured and five statements that serve to determine to what extent the subject accepts or rejects that attitude. (See Appendix C.) For example, to measure the subject's desire to teach science, one would focus on the following two position statements:

> "P - The idea of teaching science is attractive to me; I understand science and I can teach it.
>
> N - I do not like the thought of teaching science" (Moore, 1973, p. 272).

The first statement is obviously a positive position statement, while the second is a negative position statement. Each of these position statements is represented by 5 statements that the subjects are asked to respond to on a Likert-type scale by selecting one of the following: (1) agree strongly; (2) agree mildly; (3) disagree mildly; (4) disagree strongly. If a student agrees strongly with a statement from the positive scale, a positive attitude is demonstrated. On the contrary, if a subject agrees strongly with a statement from the negative scale, a negative attitude is demonstrated.

The responses are hand scored using the instructions in Appendix D and the form in Appendix E. The maximum possible score is 210 and the minimum possible score is 0. The Science Attitude Inventory has a reliability coefficient of 0.934. The scales developed to assess attitudes toward the teaching of science has a test-retest reliability coefficient of 0.816.

Procedure.

Three scores for each subject are obtained from three administrations of the Science Teaching Attitude Scales during the spring 1991 semester. The scores obtained at the beginning of the methods course, before any instruction, are the pretest scores. The scores obtained at the end of the methods classes, before the students do their field work, are the midterm scores. The scores obtained upon completion of their field work in the elementary schools represent the subjects' posttest scores.

The data is summarized by comparing the pretest and midterm scores, the pretest and posttest scores, and the midterm and posttest scores for each subject. The dependent t-test is employed to determine if there is any significant change by testing the following three null hypotheses at the 95% confidence level:

$H_{\emptyset_1}$: There will be no statistically significant difference between the pretest mean and the midterm mean when tested at the 95% confidence level.

$H_{\emptyset_2}$: There will be no statistically significant difference between the pretest mean and the posttest mean when tested at the 95% confidence level.

$H_{\emptyset_3}$: There will be no statistically significant difference between the midterm mean and the posttest mean when tested at the 95% confidence level.

Finally, the findings will be presented and interpreted. The conclusions and implications for future research will also be stated.

Analysis of the Data

Purpose

Results from the three administrations of the Science Teaching Attitude Scales are presented and the three null hypotheses are tested at the 95% confidence level using the dependent t-test.

Findings and Interpretations

$H_{\emptyset_1}$: There will be no statistically significant difference between the pretest mean and the midterm mean when tested at the 95% confidence level.

Table 1 presents the pretest and midterm scores for each subject as well as the difference (D) between these two scores and the difference squared (D^2).

n = 69

Pretest		Midterm
131.72	$= \bar{X} =$	145.74
130	$= \tilde{X} =$	146
12.96	$= s =$	13.35
0.40	= s.k. =	-0.06

$\Sigma D = -967$

$\Sigma D^2 = 19649$

$t_{obt.} = -12.30$

$t_{req.} = \pm 2.00$

Table 1

Students' Pretest and Midterm Scores

Student	Pretest	Midterm	D	D^2
1	120	139	-19	361
2	127	131	-4	16
3	131	151	-20	400
4	127	136	-9	81
5	133	148	-15	225
6	153	162	-9	81
7	127	140	-13	169
8	148	160	-12	144
9	141	142	-1	1
10	121	137	-16	256
11	133	156	-23	529
12	130	139	-9	81
13	125	144	-19	361
14	110	132	-22	484
15	132	144	-12	144
16	136	162	-26	676
17	153	158	-5	25
18	160	159	1	1
19	160	166	-6	36
20	107	142	-35	1225
21	127	148	-21	441
22	124	143	-19	361
23	124	146	-22	484
24	143	156	-13	169
25	101	142	-41	1681
26	146	163	-17	289
27	116	135	-19	361
28	150	161	-11	121
29	123	148	-25	625
30	137	149	-12	144
31	134	142	-8	64
32	116	153	-37	1369
33	128	163	-35	1225
34	124	139	-15	225
35	121	144	-23	529
36	147	155	-8	64
37	128	136	-8	64
38	110	123	-13	169
39	144	158	-14	196
40	118	125	-7	49
41	128	136	-8	64
42	136	140	-4	16
43	128	148	-20	400
44	140	155	-15	225
45	129	136	-7	49
46	112	115	-3	9
47	127	157	-30	900
48	130	132	-2	4
49	133	150	-17	289
50	133	160	-27	729
51	153	174	-21	441
52	149	156	-7	49
53	148	167	-19	361
54	131	139	-8	64
55	117	125	-8	64
56	120	120	0	0
57	123	137	-14	196
58	147	163	-16	256
59	130	134	-4	16
60	120	130	-10	100
61	137	136	1	1
62	142	161	-19	361
63	143	147	-4	16
64	141	152	-11	121
65	116	125	-9	81
66	128	151	-23	529
67	149	164	-15	225
68	118	112	6	36
69	146	157	-11	121

(See Appendix F for formula and calculations for testing the first null hypothesis.)

Finding: Since the t required for 68 degress of freedom at the 95% confidence level is ± 2.00 and since the t obtained is -12.30, one must reject the first null hypothesis and conclude that there is a statistically significant difference between the pretest and midterm means.

$H_{\emptyset_2}$: There will be no statistically significant difference between the pretest mean and the posttest mean when tested at the 95% confidence level.

Table 2 presents the pretest and posttest scores for each subject as well as the difference (D) between these two scores and the difference squared (D^2).

n = 69

Pretest		Postest
131.72	$= \bar{X} =$	143.23
130	$= \tilde{X} =$	142
12.96	= s =	14.45
0.40	= s.k. =	0.26

$\Sigma D = -794$

$\Sigma D^2 = 17304$

$t_{obt.} = -8.72$

$t_{req.} = \pm 2.00$

Table 2

Students' Pretest and Posttest Scores

Student	Pretest	Posttest	D	D^2
1	120	132	-12	144
2	127	128	-1	1
3	131	136	-5	25
4	127	125	2	4
5	133	145	-12	144
6	153	172	-19	361
7	127	147	-20	400
8	148	155	-7	49
9	141	139	2	4
10	121	121	0	0
11	133	149	-16	256
12	130	141	-11	121
13	125	146	-21	441
14	110	121	-11	121
15	132	147	-15	225
16	136	156	-20	400
17	153	177	-24	576
18	160	163	-3	9
19	160	170	-10	100
20	107	136	-29	841
21	127	136	-9	81
22	124	145	-21	441
23	124	140	-16	256
24	143	152	-9	81
25	101	142	-41	1681
26	146	154	-8	64
27	116	126	-10	100
28	150	161	-11	121
29	123	128	-5	25
30	137	140	-3	9
31	134	137	-3	9
32	116	164	-48	2304
33	128	154	-26	676
34	124	147	-23	529
35	121	137	-16	256
36	147	142	5	25
37	128	141	-13	169
38	110	124	-14	196
39	144	129	15	225
40	118	129	-11	121
41	128	133	-5	25
42	136	140	-4	16
43	128	146	-18	324
44	140	154	-14	196
45	129	140	-11	121
46	112	124	-12	144
47	127	152	-25	625
48	130	137	-7	49
49	133	147	-14	196
50	133	155	-22	484
51	153	176	-23	529
52	149	136	13	169
53	148	159	-11	121
54	131	132	-1	1
55	117	122	-5	25
56	120	121	-1	1
57	123	121	2	4
58	147	145	2	4
59	130	130	0	0
60	120	124	-4	16
61	137	146	-9	81
62	142	162	-20	400
63	143	146	-3	9
64	141	156	-15	225
65	116	144	-28	784
66	128	149	-21	441
67	149	168	-19	361
68	118	119	-1	1
69	146	165	-19	361

(See Appendix G for formula and calculations.)

Finding: Since the t required for 68 degrees of freedom at the 95% confidence level is ± 2.00 and since the t obtained is -8.72, one must reject the second null hypothesis and conclude that there is a statistically significant difference between the pretest and the posttest means.

$H_{\emptyset_3}$: There will be no statistically significant difference between the midterm mean and the posttest mean when tested at the 95% confidence level.

Table 3 presents the midterm and posttest scores for each subject as well as the difference (D) between these two scores and the difference squared (D^2).

n = 69

Midterm		Postest
145.74	$= \bar{X} =$	143.23
146	$= \tilde{X} =$	142
13.35	= s =	14.45
-0.06	= s.k. =	0.26

$\Sigma D = 173$

$\Sigma D^2 = 5705$

$t_{obt.} = 2.37$

$t_{req.} = \pm 2.00$

Table 3

Students' Midterm and Posttest Scores

Student	Midterm	Posttest	D	D^2
1	139	132	7	49
2	131	128	3	9
3	151	136	15	225
4	136	125	11	121
5	148	145	3	9
6	162	172	-10	100
7	140	147	-7	49
8	160	155	5	25
9	142	139	3	9
10	137	121	16	256
11	156	149	7	49
12	139	141	-2	4
13	144	146	-2	4
14	132	121	11	121
15	144	147	-3	9
16	162	156	6	36
17	158	177	-19	361
18	159	163	-4	16
19	166	170	-4	16
20	142	136	6	36
21	148	136	12	144
22	143	145	-2	4
23	146	140	6	36
24	156	152	4	16
25	142	142	0	0
26	163	154	9	81
27	135	126	9	81
28	161	161	0	0
29	148	128	20	400
30	149	140	9	81
31	142	137	5	25
32	153	164	-11	121
33	163	154	9	81
34	139	147	-8	64
35	144	137	7	49
36	155	142	13	169
37	136	141	-5	25
38	123	124	-1	1
39	158	129	29	841
40	125	129	-4	16
41	136	133	3	9
42	140	140	0	0
43	148	146	2	4
44	155	154	1	1
45	136	140	-4	16
46	115	124	-9	81
47	157	152	5	25
48	132	137	-5	25
49	150	147	3	9
50	160	155	5	25
51	174	176	-2	4
52	156	136	20	400
53	167	159	8	64
54	139	132	7	49
55	125	122	3	9
56	120	121	-1	1
57	137	121	16	256
58	163	145	18	324
59	134	130	4	16
60	130	124	6	36
61	136	146	-10	100
62	161	162	-1	1
63	147	146	1	1
64	152	156	-4	16
65	125	144	-19	361
66	151	149	2	4
67	164	168	-4	16
68	112	119	-7	49
69	157	165	-8	64

(See Appendix H for formula and calculations.)

Finding: Since the t required for 68 degrees of freedom at the 95% confidence level is ± 2.00 and since the t obtained is 2.37, one must reject the third null hypothesis and conclude that there is a statistically significant difference between the midterm and the posttest means.

Conclusions and Implications

Purpose

Conclusions are stated based on the results of the statistical testing performed. Interesting findings are considered. Finally, implications for future research are stated.

Conclusions

In testing the first null hypothesis, it is found that there is a statistically significant difference between the pretest mean score of 131.72 and the midterm mean score of 145.74 when tested at the 95% confidence level. In addition, the difference between these two mean scores surpasses the criterion of importance, according to Cohen's Formula. (See Appendix I.) Therefore, the elementary science methods classes at the State University of New York College at Brockport are demonstrated effective in producing significantly positive changes in attitude toward science and science teaching in elementary education students. This supports the findings of Lawrenz and Cohen (1985).

Similarly, the rejection of the second null hypothesis indicates that there is a statistically significant difference between the pretest mean score of 131.72 and the posttest mean score of 143.23 when tested at the 95% confidence level. Therefore, upon completion of their field work, the students demonstrated significant growth of positive attitudes as compared to those they possessed at the beginning of the semester. It is important to note that the difference between the pretest mean score and the posttest mean score barely surpasses the criteria of importance, according to Cohen's formula.

Finally, in testing the third null hypothesis at the 95% confidence level, it is found that there is a statistically significant difference between the midterm mean score of 145.74 and the posttest mean score of 143.23. Although this demonstrates that the students' attitudes toward science and science teaching became significantly less positive during their field work, this change does not exceed the criterion of importance, according to Cohen's formula. Therefore it is concluded that the actual science methods classes experienced during the first half of the semester accounts for the greatest amount of positive attitudinal change.

It is interesting to note that the students scored generally low throughout the semester on two scales in particular. The first scale under consideration states: "Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses" (R. W. Moore, Personal Communication, December 10, 1990). This is a negative scale and the majority of the students tended to agree with statements from this scale therefore demonstrating negative attitudes regarding this scale. Through the questioning of the methods instructor, it was found that most of the class time was spent focusing on the processes of science and the inquiry approach (B. Balzano, Personal Communication, June 5, 1991). Since the separation of science and technology was not discussed in the methods classes, it is reasonable to expect no improvement in attitudes relating to this scale.

The second scale which the students scored consistently low on stated: "There are certain facts in science that children should know" (R. W. Moore, Personal Communication, December 10, 1990). This is also a negative scale. A majority of the students agreed to some degree with these statements, therefore demonstrating low scores on this scale because it depicts a negative attitude. This seems especially interesting, since the students generally scored higher on the scale emphasizing the processes of science. These two findings appear to contradict one another, since expecting students to know facts emphasizes the product and not the processes of science. This unexpected finding might be explained by the emphasis their science content courses place on the product; the correct answer; facts.

While it is clear that the elementary science methods classes at the State University of New York College at Brockport are effective in producing the positive attitudinal changes desired in elementary teachers, this positive growth does not continue as the students complete their field work. Although the negative change during this field experience is not demonstrated to be an important one, it is obvious that the students require more reinforcement of positive attitudes toward science and science teaching during their experience in the school setting. The methods instructor indicated that not all of the teachers working with the elementary methods students during their field experience teach science (B. Balzano, Personal Communication, June 5, 1991). Therefore, some students might observe teachers who possess less than positive attitudes toward science and science teaching themselves.

Implications for Future Research

This study demonstrates that the Elementary Science Methods classes at the State University of New York College at Brockport are indeed effective in developing positive attitudes toward science and science teaching in prospective elementary teachers. Once these positive attitudes are established, how can they be maintained and further nurtured? It would be interesting to test these students again after they complete their student teaching assignments to see if the positive change is of a lasting quality.

Another question in need of further study is: To what degree does attitude toward science and science teaching upon completion of the elementary science methods course predict that these students will go on to teach science processes, use the inquiry approach and generally demonstrate these positive attitudes in their teaching style? Positive attitudes would be developed to no avail if these students are not offered settings in which they feel secure practicing these teaching methods. Therefore, more must be done to improve the attitudes of practicing elementary teachers and curriculum developers so the positive changes in attitude toward science and science teaching on the part of preservice teachers is not extinguished once they enter the school setting and become practicing teachers themselves.

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Appendix

Appendix A

Letter of Permission to Use S.T.A.S.

MIAMI UNIVERSITY

School of Education and Allied Professions
Assistant Dean
200 McGuffey Hall
Oxford, Ohio 45056
513 529-6418

December 10, 1990

Gretchen A. Northrup
[redacted]

Dear Ms. Northrup:

I hereby grant you permission to use the *Scientific Attitude Inventory* (SAI) or the *Science Teaching Attitude Scales* (STAS) in your current study for your master's degree. In your letter, you requested permission for the SAI, but the narrative leads me to believe that you want to use the STAS. The SAI is a more general inventory of attitudes toward science. The STAS is an inventory of teachers attitudes toward science and science teaching. Since you indicated that you would be using the instrument with a groups of students in science methods classes, I believe you will get better and more useful information using the STAS.

A copy of the *Science Teaching Attitude Scales* and scoring information is enclosed with this letter. I would be pleased to see a copy of your results. Good luck with your work.

Sincerely,

Richard W. Moore
Assistant Dean

Appendix B

Instructions and Science Teaching Attitude Scales

WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?

There are some statements about science and science teaching on the next few pages. Some statements are about a person's feelings about science. Some of these statements describe views about how science should be taught. You may agree with some of the statements and you may disagree with others. That is exactly what you are asked to do. By doing this, you will show your attitudes toward science and science teaching.

After you have carefully read a statement, decide whether you agree or disagree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. Then, find the number of that statement on the answer sheet, and blacken the space by the

A if you agree strongly.

B if you agree mildly.

C if you disagree mildly.

D if you disagree strongly.

Example:

00. I would like to have many friends.

00. A ████ B ______ C ______ D ______

(The person who marked this example agrees strongly with the statement, "I would like to have many friends.")

Please respond to each statement and blacken only one space for each statement. Please do not make any marks on this test booklet.

WHAT IS YOUR ATTITUDE TOWARD SCIENCE
AND SCIENCE TEACHING?

1. It is important for children to learn that the air is approximately 20% oxygen -- at least by the sixth grade.
2. There is no need for the public to understand science in order for scientific progress to occur.
3. Most children should be able to design experiments-- at least by the sixth grade.
4. Most people are not able to understand the work of science.
5. When something is explained well, there is no reason to look for another explanation.

6. A teacher should be a resource person rather than an information-giver in science.
7. The products of scientific work are mainly useful to scientists; they are not very useful to the average person.
8. I do not understand science, and I do not want to teach it.
9. A scientist must be imaginative in developing ideas which explain natural events.
10. After all is said and done, it is really the teacher who tells the children what they have to learn and know.
11. Some questions cannot be answered by science.
12. In teaching science, a teacher might spend more time listening to the children than talking to them.
13. Before one can do anything in science, he must study the writings of the great scientists.
14. Rapid progress in science requires public support.
15. Process skills are very important things to be developed in science.
16. Scientists believe that nothing is known to be true with absolute certainty.
17. A major purpose of science is to help man live more comfortably.

18. A new theory may be accepted when it can be shown to explain things as well as another theory.
19. Children must learn certain basic facts in elementary science so they can do well in science in junior high.
20. Scientists do not need public support; they can get along quite well without it.
21. I understand science and I want to teach it.
22. Every citizen should understand science because we are living in an age of science.
23. Children must be told what they are to learn if they are to make progress in science.
24. Science is so difficult that only highly trained scientists can understand it.
25. A teacher has a responsibility to teach the basic processes of science.
26. His senses are one of the most important tools a scientist has.
27. Science may be described as being primarily an idea-generating activity.
28. Ideas are one of the more important products of science.
29. As children experiment, a teacher may give helpful hints, but not the answer to a problem.

30. Science is pretty easy to understand.
31. The value of science lies in its theoretical products.
32. Process skills are the most important things to be developed by children in science.
33. A major purpose of science is to produce new drugs and save lives.
34. I like science, and I probably will be (am) a better science teacher than most other teachers.
35. Science is devoted to describing how things happen.
36. I am afriad to teach science because I can't do the experiments myself.
37. Public understanding of science is necessary because scientific research requires financial support through the government.
38. I just never will understand science.
39. People need to understand the nature of science because it has such a great affect upon their lives.
40. A teacher has a responsibility to teach the basic facts of science.
41. Scientists discover laws which tell us exactly what is going on in nature.
42. The idea of teaching science scares me.

43. Demonstrations should be used frequently so the children will understand what their teachers tell them.

44. Scientists believe that they can find explanations for what they observe by looking at natural phenomena.

45. Scientific laws cannot be changed.

46. If an experiment does not come out right, the teacher should tell the children the answer so they will not be lost.

47. There are some things which are known by science to be absolutely true.

48. It is the teacher's responsibility to tell children which things are important for them to know.

49. I do (will) not teach very much science.

50. An important purpose of science is to help men to live longer.

51. A useful scientific theory may not be entirely correct, but it is the best idea scientists have been able to think up.

52. Today's electric appliances are examples of the really valuable products of science.

53. It is important for children to learn how to control variables in an experiment--at least by the sixth grade.

54. I am well-prepared to teach science.

55. The teacher should arrange things so that children spend more time experimenting than listening to her in science.

56. Scientists are always interested in improving their explanations of natural events.

57. The value of science lies in its usefulness in solving practical problems.

58. I think I understand the nature of science and science teaching pretty well.

59. Most people are able to understand the work of science.

60. Scientific explanations can be made only by scientists.

61. Most children should know that the blood carries oxygen to the cells--at least by the sixth grade.

62. We can always get answers to our questions by asking a scientist.

63. Scientific laws have been proven beyond all possible doubt.

64. Looking at natural phenomena is a most important source of scientific information.

65. A major function of the teacher in teaching science is to help children identify problems.

66. If a scientist cannot answer a question, all he has to do is ask another scientist.

67. Anything we need to know can be found out through science.

68. It is important for children to know why iron rusts--at least by the sixth grade.

69. Scientific ideas may be said to undergo a process of evolution in their development.

70. Scientists cannot always find the answers to their questions.

Appendix C

Scale	Attitudes Assessed by "What is Your Attitude Toward Science and Science Teaching?"	Items used to assess each attitude
1-P	The laws and/or theories of science are approximations of truth and are subject to change.	16, 18, 51, 56, 69
1-N	The laws and/or theories of science represent unchangeable truths discovered through science.	5, 41, 45, 47, 63
2-P	Observation of natural phenomena is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.	11, 26, 44, 64, 70
2-N	The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answers to all questions.	13, 60, 62, 66, 67

3-P	Science is an idea-gathering activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.	9, 27, 38, 31, 35
3-N	Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.	17, 33, 50, 52, 57
4-P	Progress in science requires public support in this age of science, thefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.	14, 22, 37, 39, 59
4-N	Public understanding of science would contribute nothing to the advancement of science or to human welfare, therefore, the public has no need to understand the nature of science. They cannot understand it, and it does not affect them.	2, 4, 7, 20, 24

5-P	The idea of teaching science is attractive to me; I understand science and I can teach it.	21, 30, 34, 54, 58
5-N	I do not like the thought of teaching science.	8, 36, 38, 42, 49
6-P	There are certain processes in science which children should know, i.e., children should know how to do certain things.	3, 15, 25, 32, 53
6-N	There are certain facts in science that children should know.	1, 19, 40, 61, 68
7-P	Science teaching should be guiding or facilitating of learning. A teacher becomes a resource person.	6, 12, 29, 55, 65
7-N	Science teaching should be a matter of telling children what they are to learn.	10, 23, 43, 46, 48

Appendix D

Instructions to Hand Score the Science Teaching Attitude Scales

The Science Teaching Attitude Scales may be hand scored using the attached form and the following procedures:

1. Enter the student's response (1, 2, 3, or 4) in the first space to the right of the item number.
2. Enter a value for each response in the second space to the right of the item number according to the following:

   A. For the "P" scales,

      if the response is a 1, enter a 3.
      if the response is a 2, enter a 2.
      if the response is a 3, enter a 1.
      if the response is a 4, enter a 0.
      if the response is a blank, enter a 1.5.
      if the response is an error, enter a 1.5.

   B. For the "N" scales,

      if the response is a 1, enter a 0.
      if the response is a 2, enter a 1.
      if the response is a 3, enter a 2.
      if the response is a 4, enter a 3.

if the response is a blank, enter a 1.5.

if the response is an error, enter a 1.5.

3. Find the sum of the values for the five responses for each scale.
4. Find the total score by summing the scores for the fourteen scales.

Appendix E

Form Used To Hand Score

the Science Teaching Attitude Scales

1P			5P			1N			5N		
16			21			5			8		
18			30			41			36		
51			34			45			38		
56			54			47			42		
69			58			63			49		

2P			6P			2N			6N		
11			3			13			1		
26			15			60			19		
44			25			62			40		
64			32			66			61		
70			53			67			68		

3P			7P			3N			7N		
9			6			17			10		
27			12			33			23		
28			29			50			43		
31			55			52			46		
35			65			57			48		

4P			4N		
14			2		
22			4		
37			7		
39			20		
59			24		

Appendix F

Formula for the Dependent t-Test

and Calculations for the

First Null Hypothesis

$H_{\emptyset_1}$:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{n * (\Sigma D^2) - (\Sigma D)^2}{n^2 * (n - 1)}}}$$

$$t = \frac{131.72 - 145.74}{\sqrt{\frac{69 * (19649) - (-967)^2}{69^2 * 68}}}$$

$$t = \frac{-14.02}{\sqrt{\frac{1355781 - 935089}{4761 * 68}}}$$

$$t = \frac{-14.02}{\sqrt{\frac{420692}{323748}}}$$

$$t = \frac{-14.02}{\sqrt{1.30}}$$

$$t = \frac{-14.02}{1.14}$$

$$t = -12.30$$

According to Cohen's Criteria for judging the scientific importance of a statistically significant difference between means based on the same sample of subjects, a difference of 10.87 points is required. The difference of 14.02 (145.72-131.72) meets this requirement.

Appendix G

Formula for the Dependent t-Test

and Calculations for the

Second Null Hypothesis

$H_{\emptyset_2}$:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{n * (\Sigma D^2) - (\Sigma D)^2}{n^2 * (n-1)}}}$$

$$t = \frac{131.72 - 143.23}{\sqrt{\frac{69 * (17304) - (-794)^2}{69^2 * 68}}}$$

$$t = \frac{-11.51}{\sqrt{\frac{1193976 - 630436}{4761 * 68}}}$$

$$t = \frac{-11.51}{\sqrt{\frac{563540}{323748}}}$$

$$t = \frac{-11.51}{\sqrt{1.74}}$$

$$t = \frac{-11.51}{1.32}$$

$$t = -8.72$$

According to Cohen's Criteria for judging the scientific importance of a statistically significant difference between means based on the same sample of subjects, a difference of 10.87 points is required. The difference of 11.51 (143.23-131.72) meets this requirement.

Appendix H

Formula for the Dependent t-Test and Calculations for the Third Null Hypothesis

H_{0_3}:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\dfrac{n * (\Sigma D^2) - (\Sigma D)^2}{n^2 * (n-1)}}}$$

$$t = \frac{145.74 - 143.23}{\sqrt{\dfrac{69 * (5705) - (173)^2}{69^2 * 68}}}$$

$$t = \frac{2.51}{\sqrt{\dfrac{393645 - 29929}{4761 * 68}}}$$

$$t = \frac{2.51}{\sqrt{\dfrac{363716}{323748}}}$$

$$t = \frac{2.51}{\sqrt{1.12}}$$

$$t = \frac{2.51}{1.06}$$

$$t = 2.37$$

According to Cohen's Criteria for judging the scientific importance of a statistically significant difference between means based on the same sample of subjects, a difference of 10.87 points is required. The difference of 2.51 (145.74-143.23) does not meet this requirement.

Appendix I

Calculation of Cohen's Criteria of Importance of the Statistically Significant Difference Between Means

$$\text{Cohen's criteria of importance} = \frac{s_{X_1} + s_{X_2} + s_{X_3}}{3} * 0.8$$

$$= \frac{12.96 + 13.35 + 14.45}{3} * 0.8$$

$$= 13.587 * 0.8$$

$$= 10.870$$